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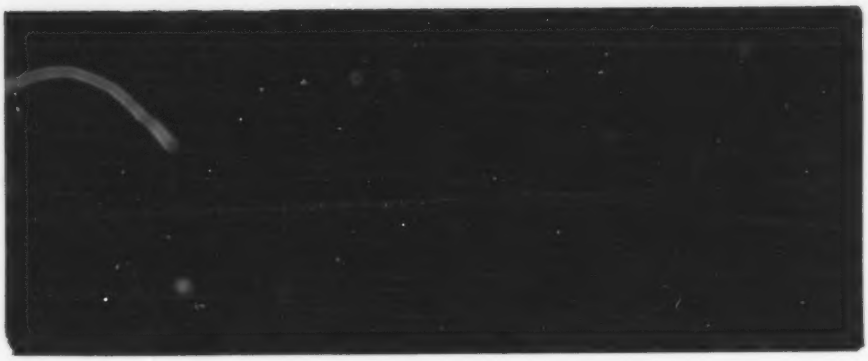

Technical/Final Report
to
Saskatchewan Agriculture Development Fund

Development of a System for Evaluating Hoof and Limb Conformation and Soundness During R.O.P. Test

2.4-11

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FINAL REPORT Project No 2.4-11

"Development of a System for Evaluating Hoof and Limb Conformation and Soundness during R.O.P. Test"

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EXECUTIVE SUMMARY

A "CONFORMATION DETERMINATION SYSTEM" (C.D.S.) was created to measure accurately the dimensions of the bones of the hind limb and the angles of the joints.

Five special points on the hind limb are marked. Following strict rules, a 35mm photographic transparency is produced. The transparency is projected onto a digitizing pad which permits the points on the animals body to be entered into a computer. C.D.S processes the information entered and calculates selected measurements and angles. Averages for any measurement for any breed, age or sex are calculated automatically and compared with data for each individual animal.

At the end of the 1986/7 trial approximately 140 bulls met the standards of R.O.P. of which 22 were rejected for "Feet and Legs". Of this number 18 showed clinical signs indistinguishable from laminitis.

LAY SUMMARY

A "CONFORMATION DETERMINATION SYSTEM" (C.D.S. was created with the objective of measuring accurately the dimensions of the bones of the hind limbs and the angles of the joints. As the project progressed it was found possible to include most of the important body measurements. CDS now includes the capability of measuring the hoof.

CDS was developed in the first place was to investigate the reasons for such a high percentage of of R.O.P. bulls being rejected on the grounds of "Feet and Legs". By implication the problem was allegedly one of "defective conformation" therefore logically the first step would be to develop a system to measure the size and shape of the animals limbs and hooves. CDS has become, quite by accident, a system that is perceived by producers as an important device that can be used in the genetic improvement of livestock. Although there is real potential for using CDS for this purpose, at least seven months of further work would be required before field testing would be justified. At this time the error margin for CDS is less than 5% when used consistently by the same operator. During an independent research project the height at the loin was measured manually and also with CDS, there was no statistically significant difference between the two measurements. In the meantime CDS functions extremely well as a device that will identify those simple conformational defects that could be predisposing causes of lameness. However, during the study of the R.O.P. bulls C.D.S. did not reveal any conformational defects that were not obvious to the naked eye.

After the final weighing of the R.O.P. bulls in March 1986, those that met acceptable R.O.P. standards were examined for feet and legs by experienced stockmen. Twenty-two animals were rejected of which four were eliminated because of either injury or very obviously unacceptable conformation. The official examiners rejected the remaining eighteen animals on the grounds of poor conformation. However, to the veterinary observer the changes in the manner in which the animals were walking were indistinguishable from laminitis. No further studies on these bulls were possible because they were returned to their owners and presumably sold.

It was thought likely that some of the bulls that had failed to meet R.O.P. standards would also be showing signs of laminitis. For this reason the hooves of eighty R.O.P. bulls sent to slaughter were examined. A significant percentage of these hooves showed changes that have been described by research workers as being related to laminitis. When sections of the hooves were examined, several changes were seen that had never been previously described. At this point the question was raised, "What is normal?" For the purpose of further clarification. The hooves of 40 bulls on feeding trials at the University Feedlot were harvested. The clinical signs seen in the R.O.P. bulls, though present, were not as advanced. However, the feeding program of the second group differed from that of the R.O.P. bulls. No definitive conclusions could be reached. In the search for further clarification the hooves of steers from feedlots were examined. In this case some of the signs were completely absent while others were exaggerated. From a subjective point of view there seemed to be a correlation between the poorest ration and the magnitude of some of the changes.

The bulls in the 1986/7 trials were only examined clinically for " feet and legs" on March 25th 1987. Clinical signs indistinguishable from laminitis were again observed but they were not as pronounced as in the 1985/6 bulls. The evaluators concentrated their efforts this year on the changes in gait that resulted from hoof growth abnormality.

Discussion

To the outsider this project must seem extremely confusing because changes in direction have occurred within the study. The reason for this is that at several stages opportunities existed to explore exciting new developments and observations for which there was no obvious explanation.

The development of C.D.S. was intended to produce a tool that would evaluate the role that conformation would play in "feet and leg" unsoundness. A point in the development of C.D.S. was reached at which the system was able to function effectively in producing data considerably beyond the scope of the lameness study. It became obvious that with further development C.D.S. could aid breeders in objectively evaluating conformation for the genetic improvement of cattle. CDS, therefore, must be viewed from two perspectives, first as a support system in the study of lameness (the purpose for which it was developed in this project) and secondly as a system that has very great potential to be developed as a tool to be used in the genetic improvement of cattle.

The observation of a laminitis like condition in the bulls was an unexpected finding that poses more problems than it solves. The evaluation of "feet and legs" is very valid. The culling of the bulls was carried out on the basis of skilled observation and logical, knowledgeable reasoning. Without doubt this practice should continue unaltered for the immediate future.

It must be appreciated that the defects observed in the "feet and legs" examination were caused by events (or insults) that took place some months earlier. Culling animals for apparently different reasons is at first confusing. The explanation may be that the effect of an insult can vary according to the sensitivity of the animal. That is to say, the genetic makeup of some bulls might make them react either more strongly or more quickly than others. This would explain why some animals had sore feet and that others did not. It would rationalize why some animals had abnormal hooves and others did not. It could be argued, on this basis, that selection might be unfairly biased because some bulls that had sore claws after 120 days of test might not be sore at 140 days. It could be suggested that an animal that appears perfectly normal at 140 days might develop serious hoof problems during its first breeding season. Bulls sold to community pastures reportedly do have "Feet and Leg" problems during their first breeding season. The follow up (only 80 responses received out of a possible 120) on the 1985/6 test bulls revealed that a top performer had succumbed to acute laminitis and two others may have had difficulties.

"Feet and Leg" soundness is extremely important and the examiners act correctly during the end of test examination. One can only speculate if the same animals would be culled if examined at 120, 140 and 160 days of test.

TECHNICAL REPORT

The technical report is divided into two distinct parts. The first describes the unexpected finding of the "laminitis like condition" that was observed in the R.O.P. bulls the second is a progress report on the development of a "Conformation Determination System".

A PRELIMINARY REPORT ON A LAMINITIS LIKE CONDITION OCCURRING IN BULLS UNDER FEEDING TRIALS

ABSTRACT

One hundred and forty one bulls met the Register of Performance Standards at the Saskatoon R.O.P. station in 1986. Eighteen of these animals were culled for clinical signs indistinguishable from laminitis. Of the one hundred and eighty three bulls that failed to meet the R.O.P. standards sixty five were slaughtered and the claws of both hind limbs were examined. Hemorrhages and other lesions were observed in a high percentage of the claws a finding that supported the clinical finding that a condition indistinguishable from laminitis was present in the group.

OBJECTIVE

The objective of the study was to develop a system for evaluating hoof and limb soundness during R.O.P. testing.

BACKGROUND

Each year over three hundred bulls enter the Saskatoon Feed testing station and each year about forty percent of the group meet the standards set for food conversion, back fat thickness and testicular circumference. Of these successful bulls upto twenty five percent are rejected by "evaluators" on the basis of unsound conformation. In October of 1985 we were asked to evaluate the "feet and legs" of bulls undergoing feeding trials.

Our assignment, therefore, was to define, in objective terms the reasons for the culling.

Because it had been suggested that poor limb and hoof conformation was likely to be an important consideration our initial efforts were directed towards developing a system for measuring the conformation of the bulls under trial.

EXPERIMENTAL METHODS

Three hundred and twenty-four bulls from six breeds all born in 1985 entered the Saskatchewan R.O.P. station in November 1985. After one week of acclimatization they were placed on ad lib feeding. The ration consisted of barley silage fed at a ratio of 3.75 to 3.21bs of silage to 1lb of concentrate mix. The ration on a dry matter basis had 50% roughage and 50% concentrate. The formulation contained 15.5% protein on a dry matter basis from Oct. 31 and 13.5% protein from Jan. 1 to March 25.

All of the bulls were marked at selected anatomical points and photographed. The transparencies produced were projected onto a digitization pad, the data was fed directly into the computer and processed. The results of this analysis will be reported at a later date.

On March the 27th, 1986, 141 bulls that had met the standards described above were examined by two individuals who had considerable experience in judging the conformation of beef cattle.

The evaluators rejected 22 bulls of which 2 had clear conformational defects, 2 were lame because of injury and one appeared to have epiphysitis.

RESULTS

The evaluators justified their decisions in terms of conformational deficiency. It was our opinion that all of the deficiencies described as being defects in conformation were, aberrations of gait. These aberrations of gait were indistinguishable from those associated with laminitis in cattle. The following are our observations:

1. Three animals carried one or both limbs well under the body i.e Camped under or "protracted the limb" (evaluators comment - sickle hock).
2. Two animals bore weight only on the outer hind claw (evaluators comment - bow legged).
3. Three animals extended the fore limbs unusually far forward "protraction of the limb" (evaluators comment - needed hoof trim).
4. Five animals "knuckled at the pastern" (maintained flexion of the metatarso-phalangeal joint throughout weight-bearing) of the hind limb. This appeared to be a distinct effort to avoid bearing weight on the heels (evaluator comment - bad on the hind feet).
5. The remaining animals had a "stilted" gait.

Aberdeen Angus bulls were much less troubled by hoof problems than were the other breeds. Black horn is considered by many to have qualities superior to that of light colored horn.

An analysis of the data revealed the following:-

i) of 33 charolais 12% (4) were rejected for aberration of gait,
ii) of 39 herefords 10% (4) were rejected for aberration of gait,
iii) of 23 simmentals 21% (5) were rejected for aberration of gait.

Our observations confirmed those of the lay evaluators in respect to those animals that they had rejected. However, we observed twenty other animals showing suspicious aberrations of gait but to a lesser degree than the rejected bulls.

Although 22 animals were rejected on "feet and legs" only one laminitic animal was slaughtered, the remainder were returned to the owner presumably for private sale. However, of the original 324 bulls we were able to examine the hind hooves of a total of 65 bulls. The following was observed in the specimens examined:-

1. Check Lines - 92% incidence. We are defining a check line as a groove running more or less parallel to the coronary band.

2. Check Bands - 92% incidence. We are defining a check band as the region between the check line and the coronary band (or another check line) that differs in texture from the horn of the distal extremity of the hoof.

TABLE 1

Breed	(Total)	Width of Band at dorsal surface(av)	Width of band at abaxial groove(av)
Angus	(13)	2.53	3.3
Charolais	(9)	2.88	3.93*
Hereford	(17)	2.59	3.67
Shorthorn	(3)	2.83	4.00
Simmental	(18)	2.73	3.71
Maine-Anjou	(2)	2.75	3.95

* Three of the specimens did not show check line/band

3. Hemorrhages of the wall and sole Numerous hemorrhages were observed in the walls of the hooves of the bulls. We classified the hemorrhages into three groups on the basis of appearance.

Group One - Discrete An area of red discoloration of the wall of the hoof that does not exceed 1 cm in diameter.

Group Two - Diffuse An area of pinkish tinge affecting an ill defined area.

Group Three - Linear Similar in width and appearance to the discrete hemorrhage but extending as a band several centimeters long running parallel to the coronary band.

TABLE II

	Number of hemorrhages observed in individual claws of 65 bulls							
		NONE		1		2		3	
Breed	(TOTAL)	Med	Lat	Med	Lat	Med	Lat	Med	Lat
Angus	13	11	12	1	0	1	1	0	0
Charolais	12	2	3	5	4	5	3	0	2
Hereford	17	2	2	6	5	7	9	2	1
Maine-Anjou	2	0	0	1	2	1	0	0	0
Shorthorn	3	1	1	2	2	0	0	0	0
Simmental	18	0	0	7	6	8	10	3	2

The data set down in Table II demonstrates a trend which may or may not be repeatable. Most conveniently the findings may be summarized in the following manner.

88.50%	of the claws of	13	angus	bulls showed no hemorrhages
21.00%	of the claws of	12	charolais	bulls showed no hemorrhages
11.75%	of the claws of	17	hereford	bulls showed no hemorrhages
0.00%	of the claws of	2	maine-anjou	bulls showed no hemorrhages
33.00%	of the claws of	3	shorthorn	bulls showed no hemorrhages
0.00%	of the claws of	18	simmental	bulls showed no hemorrhages

Two additional groups of purebred bulls were on feed trials. The feeding was identical to the R.O.P. bulls with the exception that in one group oats were used and in the other barley.

2.50%	of the claws of	20	purebred bulls fed oats showed no hemorrhages
5.25%	of the claws of	19	purebred bulls fed barley showed no hemorrhages

As a control we harvested the claws of 14 cross-bred bulls and 14 cross-bred steers. These animals had received creep feed prior to weaning and were fed a ration that was initially lower in energy than the R.O.P bulls but approximately comparable in protein content. Significantly less silage was fed throughout the feeding period. The detailed ration changes were approximately as follows.

Sept. 24/85	80% silage	15.0% Barley	5% Canola		
Oct. 31/85	50% silage	35.0% Barley	5% Canola	10.0% Hay	
Jan. 3/86		27.5% Barley	15% Canola	57.5% Hay	
Feb. 21/86		60.0% Barley	10% Canola	5.0% Hay	25% Straw
Feb. 24/86		70.0% Barley	5% Canola	5.0% Hay	20% Straw

The claws of the controls showed the following:

85.75%	of 14	cross-bred steers	showed no hemorrhages
68.00%	of 14	cross-bred bulls	showed no hemorrhages

4. Erythema and edema of the coronet or peri-coronal epidermis
   Usually the discoloration of these areas is pink but occasionally they take on a blue, cyanotic appearance, this phenomenon was observed in some of the living animals.

We were unable to produce any evidence regarding histological changes in the corium of the digits examined. A section of the hoof taken through the areas of hemorrhage showed that the bleeding had taken place into the substance of the horn. The hemorrhages in the wall sloped diagonally through the wall from a point of origin at the corium distally through the stratum medium to the stratum externum. Similar sections through the sole showed that hemorrhages had occurred at intervals giving an appearance similar to the rings in a tree. We also noted that the lines of hemorrhage that occurred in the bearing surface of the heel merged with the areas of erosion that occurred in the heels of some of the animals.

DISCUSSION

The presence of check lines and check bands has been reported in the literature (Peterse, 1980). In our current study it seems that the check line was formed either at the time the animal was introduced to feed or at

the time of weaning. In future studies we propose to evaluate the weaning protocol in order to investigate possible correlations between the techniques employed and the severity of the check line/band. The data recorded in Table I, we believe, indicates that in a period of approximately 140 days the average growth of horn on the dorsal surface of the hoof was approximately 2.75 cm (5.8 mm/month) and at the abaxial groove 3.75 cm (8.12 mm/month). These figures suggest that the rate of horn production may be greater in this sample of animals than has been previously regarded as normal for adult animals.

The R.O.P bulls, plus the thirty-nine additional bulls on independent feed trials were all fed rations containing a large amount of silage. These animals all showed hemorrhages. The group of bulls and steers that were fed much less silage were also less troubled by hemorrhages. It is interesting to note that good quality silage contains high levels of lactic acid. We could postulate that if at the same time a high energy ration was fed the levels of lactic acid could become dangerously high. The currently accepted theory concerning the etiology of laminitis suggests that lactic acidosis plays an important role.

Our subjective evaluation of the aberrations of gait that we observed suggested to us that the clinical manifestation of laminitis in cattle can be more complex than it is in the horse. The phenomenon of knuckling at the fetlock was particularly interesting because in each case the animal failed to bear its full weight on the heel suggesting that pain was present. We have observed laminitis occurring in one claw on several occasions. In this study it appeared that several animals were bearing more weight on a lateral than medial claw giving the bow legged appearance noted by the evaluators.

The number of hemorrhages observed in the claws of the limbs examined, we believe, is likely to be significant. The hemorrhages must be a historical record of an event that took place some weeks or months prior to slaughter. Our reasoning is that the hemorrhages occur in layers between apparently normal horn. Logically, therefore neither the hemorrhage nor the check line/band are obviously directly connected with the aberrations of gait. The bulls were maintained in corrals on soft bedding and the aberrations of gait were only apparent when the animals walked on a concrete roadway. The sole of all the hooves were thick in comparison to the hooves of other bulls and steers examined at random from slaughter house material. This could imply that the ration stimulated horn growth to such an extent that weight bearing was transferred from the wall to the center of the sole. This possible change of weight bearing may have been incidental in precipitating the clinical signs observed.

Our observation linking layers of hemorrhages with the lines of erosion of the heel we believe could be an important finding. The etiology of heel erosion has been difficult to substantiate but we suggest that our observation does establish the suspected relationship between laminitis and erosion.

CONCLUSIONS AND ECONOMIC IMPACT

The majority of the bulls that were culled for conformational defects had no such defects but were affected with laminitis. Most veterinary texts indicate that an animal that has once been affected with laminitis will be susceptible to a recurrence of the condition. The Saskatoon bull testing station is one of several in Canada all of which feed rations comparable to

that used in Saskatoon. There has been no indication that a laminitis like condition has been observed in any other Canadian bull testing station. The possibility that the phenomenon might be observed in other feeding stations is at least tenable on the grounds that the feeding regimen is comparable.

The animals passing through the Register of Performance (R.O.P.) stations represent a substantial part of Canada's genetic pool. If locomotory unsoundness were to be a significant problem in this genetic pool significant economic losses would be involved.

The practice of "fitting" young bulls for bull sales is widespread. This practice involves intensive feeding in order achieve heavy weight gains by the time that the animal enters the second year of its life. Many of these heavy young bulls find their way into community pastures. (These are areas set aside for the benefit of ranchers who send cattle there in the spring hopefully to retrieve them pregnant in the fall).

Figures on the number of bulls disposed of, from community pastures in Saskatchewan, over a five year period due to foot and leg problems are available. The problems do not include injury, footrot or corns, but do include deformities that may be inherited.

TABLE III

Year	Total Bull herd	Total Culls	Lameness Culls
1982	1456	355	72
1981	1541	361	80
1980	1772	375	90
1979	1692	306	81
1978	1573	327	68

The rate of attrition due to lameness seems to be high. The relationship between the practice of "fitting" young bulls for bulls sales with a high incidence of lameness in later life has not been studied.

A REPORT ON THE INITIAL PHASE IN DEVELOPMENT OF A COMPUTERIZED TECHNIQUE FOR RECORDING, MEASURING AND ANALYZING SKELETAL SHAPE AND SIZE IN CATTLE

ABSTRACT

A system has been developed which permits measurements to be taken of various body dimensions and joint angles of an animal from a 35mm photographic transparency. Prior to photography six strategic anatomical points on the animal are marked. The transparency is projected onto a digitizing pad from which data is loaded into an I.B.M. compatible computer. A specially developed program compensates, mathematically, for the distortions created when a three dimensional object is converted to a two dimensional image. The program transfers the data to a storage file. Initial trials indicates that the system is practical for use in the field and has an error margin of less than 5%

BACKGROUND

The Conformation Determination System C.D.S. was developed with the intended use of providing an objective method of measuring parameters of cattle shape and size which could be predisposing causes for the culling of beef bulls on R.O.P. test. A study of the literature soon revealed very little information about any measuring methods that were not either very time consuming or highly impractical when dealing with fraxious young bulls in a confined space. The R.O.P. committee permitted seven minutes for a complete examination to be made without elevating the limb or otherwise stressing the animal.

Several trials were initiated using photographs. The initial work was totally unsuccessful. However, it proved possible to modify a system used in orthodontic surgery and with the help of engineers from space and atmospheric studies the C.D.S. system was devised. Constant modifications have had to be made inorder to refine the system and also to incorporate the recommendations of, what appears to be, a very enthusiastic cattle industry.

As it transpired, conformational defects did not appear to be involved in the problem under study. Therefore, C.D.S. came into being under a misconception or by fortuitous accident.

OBJECTIVES

To develop a simple to use system that will, under field conditions, provide a rapid method for producing accurate data on important body measurements of cattle. The system would be a tool that will :-

a) Correlate locomotory disease with conformational defects.
b) Measure growth characteristics.
c) Give breeders a reliable system on which to base the evaluation of conformation.
d) Provide a system for developing correlations between conformation and carcase quality.

EXPERIMENTAL METHODS

Several assumptions about the photograph were made to provide consistency. (For details of the photographic technique see APPENDIX TWO which can serve as an instruction manual)

1) That the sagital plane of the animal is parallel to the horizontal focal plane of the camera. This was easily accomplished by ensuring that the lens to nose distance equaled the lens to tail distance.

2) That the sagital plane of the animal was parallel to the vertical focal plane of the camera and that the center of the vertical height of the animal would approximate as nearly as possible to the center of the photographic frame. These requirement were met by employing a tripod head with a leveling device and raising the tripod to approximate the center of the lens to the center of the animals vertical height.

3) That the accuracy of scale should be optimized. A one meter scale bearing identification and other data would be placed along the sagital plane of the animal and that the image of the animal would fill the frame as much as possible.

4) The animal was marked by applying water soluble paint to the following anatomical landmarks:- The tubers Ischii and Coxae, the Great trochanter, the Femoro-tibial joint, the point of the Shoulder and the Olecranon (Fig 1)

5) The transparency was then projected and adjusted to fill a rectangle drawn on a Kurta digitizing pad. The center of the image was indicated by cross lines joining opposite corners of the rectangle. The point at which the lines crossed was designated the "origin". All points digitized by the "cursor" would be later related mathematically to this origin.

The digitizing pad is provided with a row of supplementary control points. Each of these was designated a separate function. For example if a point is incorrectly digitized a supplementary control point can be activated by the cursor to allow the worker to repeat an operation. Another supplementary control point would allow the worker to terminate, another would allow the point to be omitted an so on.

When C.D.S. is activated a Menu appears. The choices offered are a) Enter data, b) Functions, c) Review data, d) Issue a report on an animal e) Return to the main Menu.

On using option a) Enter Data C.D.S (Conformation Determination System) allows the user to enter data for one or more animals in a systematic manner. The computer prompts the user to enter from the keyboard the identification code of the animal, the date that the photograph was taken, the lens used on the camera and the length of the scale that is included in the photograph. Only when this information has been completed will the computer allow digitization to take place.

Once the data from the keyboard has been completed, the image of an animal and the scale appears. These images are marked with 22 numbers located at appropriate points. Each number is place in a clear square. A brief description of the location to be digitized appears at the bottom of the screen.

7) A "cursor" is used for point digitization. The cursor consists of a transparent plastic plate 5 cm x 7 cm on which to black lines (cross hairs) intersect. An integral part of the cursor is a device that issues a pulse to the digitizing pad when a small button is pressed.

Digitization commences by placing the cross hairs of the cursor screen over the origin (#1) and pressing the button. The point to be recorded in the computer program. The computer responds by causing the clear square to disappear from around the number. The next descriptor #2 prompts the operator to the beginning of the scale. Point #3 marks the end of the scale. Points #4 and #5 mark the tips of the near side hooves from which a theoretical baseline is calculated. All the angles and the absolute height

of the animal will be calculated from this base line. The remaining points are landmarks indicated in Figure 2. When the final point has been digitized the screen prompts, "Digitize another? Y or N ".

8) C.D.S. then reads the data points and performs the mathematical calculations required to create the conformation measurements of the animal (see Table 1) These values are then loaded into a file in the database At this point the data becomes usable or produce hard copy of one or more animals in the form of a report.

RESULTS

The system has been tested at several levels.

a) The camera lens (i.e 28mm, 35mm and 55mm) and projection system. A grid pattern photographed with each lens was projected onto the digitizing pad. Analysis revealed that distortions, which undoubtedly exist were less than the accuracy of the graphics pad. The quoted accuracy of the graphics pad was 0.06cm which on an average animal would translate to an inaccuracy of about 0.4cm in its length.

b) Comparison of actual to calculated dimensions

The skeleton of a cow was marked, photographed and the measurement taken between several points using a measuring tape. The photograph taken from the specimen was then digitized and comparable measurements calculated by the system. The calculated and actual measurements were compared revealing an error of less than 4%.

c) Repeatability

Each of three dairy cows was marked at the usual anatomical points by an experienced operator and photographed. The marks were erased and the procedure repeated with each of the three animals on ten occasions. The repeatability and accuracy of an experienced operator was found to be high, the results of this test appear in the following table.

	1st Cow			2nd Cow			3rd Cow			Total Percent
FIELD	Av cm	St. Dev	%	Av cm	St. Dev	%	Av cm	St. Dev	%	Error
Pelvic Length	48.59	1.97	4.05	49.10	2.12	4.31	47.90	1.53	3.20	3.85
Pelvic Wing	31.52	0.78	2.47	32.69	1.18	3.61	31.49	0.89	2.84	2.97
Femur Length	42.63	1.51	3.54	40.87	0.95	2.34	40.26	2.04	5.07	3.65
Tibia Length	36.39	0.97	2.61	39.10	2.20	5.63	39.01	2.45	6.27	4.84
Hock Length	55.38	0.54	0.98	54.20	1.15	2.12	55.09	0.92	1.64	1.64
Hock Angle	161.75	2.25	1.39	161.62	3.23	2.00	160.72	1.91	1.19	1.53
Loin Height	146.49	1.58	1.08	147.36	2.34	1.59	145.17	2.37	1.63	1.43
Withers "	139.52	2.73	1.96	142.14	2.15	1.51	132.78	1.73	1.31	1.59
Chest Depth	88.12	1.65	1.87	87.92	1.55	1.77	80.95	1.33	1.65	1.76
Humerus Length	37.79	1.14	3.02	36.38	1.16	3.18	36.05	1.65	4.57	3.57
Body Length	155.52	3.15	2.03	159.16	2.06	1.29	155.90	3.70	2.39	1.90

Table 1

d) Human error

The components of human error were evaluated. The average for one person continually digitizing the same animal was .66% while the average error for four persons digitizing the same animal was .63%. Operators new to the system were able to produce adequate photographs using only the instruction outlined in APPENDIX I.

DISCUSSION

Wherever possible we have used landmarks and dimensions employed by other workers.

It would be inaccurate to suggest that the measurement of a bone by using the system would represents its precise length. The measurement derived from the system are however consistent in that they can be used to compare similar measurements generated by the system from photographs of cattle.

In the initial work measurements were included of the hoof and thickness of the metatarsus. However, these measurements have been omitted because it has been discovered that a small structure in a photograph covering a wide field can not be measured accurately by this system. In the next phase of our work we shall take separate photographs of the hoof and develop an appropriate C.D.S. for this area. The face length has been omitted because it was found that it was impossible to restrain an animal adequately for such photography. Originally we had planned to calculate the angle of the pelvis to the horizontal. Because the calculation of this angle has proved to be unreliable we will substitute the angle made by the line of the tuber ischii to the tuber illii in respect to the femur. We shall also include the angle made with these tubers and the great trocanter thereby suggesting the depth of the pelvis.

The system is quite easy to use even under difficult conditions or with fraxious animals but skill and experience is needed to produce consistent results. This is not to suggest that the operators need advanced photographic knowledge but must meticulously observe the guidelines set down in APPENDIX I. With experience, photographs can be produced in less than ten minutes if the animal is tractable. However, we believe that greater accuracy can be achieved if four or five photographs can be taken of each subject.

Methods of providing objective information about the rump and lower back of the cow have been investigated. Although this problem is soluble it is difficult to envisage the method that would be most useful to the industry by which "shape" can be expressed. Doubtless other areas of the animal body could be examined and the system expanded to generate a wide range of information that would be of value to the industry. It must be understood that C.D.S. is intended to be a tool and the developers have no intention of setting standards, this we believe to be the domain of the industry.

It is believed that C.D.S. when it is fully developed could be used in the objective evaluation of body type particularly in those areas where size and physical proportions are being measured. Optical illusion may be one of the weaknesses of some subjective observations. Objective evaluation can never replace those subjective observations that reflect the subtle hormonal balance of the animal body or some of the genetically controlled physical characteristics known to be linked to physiological strengths.

CONCLUSIONS AND IMPACT

The inevitable conclusion is that for the first time accurate and useful objective data can be derived about the conformation of cattle from a photograph. C.D.S. if developed to its logical maximum could be used as a tool for the genetic improvement of cattle and to establish standards by which it might be used to facilitate the growth of export markets.

PROJECT REVIEW - A PERSONAL PERSPECTIVE

P.R. Greenough

This project has been extremely interesting if difficult to handle. What started out as a simple, uncomplicated investigation evolved into an enigma. The first six months of work trying to objectively measure the parameters of bull conformation met with one set back or failure after another. The confined space in which we had to examine the bulls, the low temperatures in which we had to work, the fraxious nature of the bulls themselves together with the limitations imposed by the breeders added to the frustration and difficulties. What has evolved in C.D.S., as it exists at this time is a truly practical technique. Other systems tend to require a significant expenditure of time, co-operative animals and controlled conditions. Although the development of C.D.S is an exciting breakthrough, it is very important to avoid making premature claims or suggest a level of perfection that has not yet been attained. C.D.S. Version one is an unrefined system or "development version" that has established for the first time that with the aid of computers a photograph will generate accurate data. C.D.S Version Two should appear in three modes B. = Beef C. = Carcase D. = Dairy. Each mode would be customized for the appropriate segment of industry. The level of sophistication developed would depend on the need and available funding from industry. C.D.S. Version II should, perhaps, be referred to as the field version in the sense that it should be rigorously tested under field conditions. If at this stage C.D.S. is perceived as an essential tool for the industry then a third "industrial" version would appear. The reason for designating "versions" to C.D.S. is in order to avoid comparing apples with oranges. There will be only one place at which changes to the C.D.S. program will or can be made and that will be in Saskatoon. This will ensure that anyone using the same version will obtain comparable results so far as human error will permit. The present objective would be to have Version 2D finished by the end of 1987. Copies of Version two will be placed in reliable hands in Denmark, Holland, the United Kingdom and Australia for evaluation. Hopefully funding will become available from industry backed sources to conduct extensive field trials in Canada during 1988. If C.D.S. Ver 2,C,D,B. are accepted by the industry the development of a computerized three dimensional version of bovine conformation would begin, using aerospace technology.

Finding a "laminitis like" condition in R.O.P. was an unexpected shock to the investigators. In the months that have intervened we have gained the very distinct impression that the industry is not surprised. Beefboosters of Alberta claim the problem to be widespread. A concerned producer from Ontario despairs of the situation that province. The experienced stockman claims, probably with justification, that he can recognize the "over-fitted" animal be the way that it walks. Agribition is full of excellent examples. The industry is equivocal in how this problem should be handled. The present system of examining for "feet and legs" hands out some sort of rough justice that may be good enough. This may be true but it is <u>definitely not</u> consistent. For this reason, a new objective for the AGDF 1987-89 project should be to:- develop guidelines or "standards" for the critical evaluation

of "Feet and legs". The problems observed on day 140 of a test were caused by events that occurred many days or weeks earlier. There is no evidence to suggest that if no abnormality exists on day 140 none will occur at a critical point in the bulls breeding life.

The term "laminitis like" condition is used advisedly because it is quite possibly that several closely related factors are at work. In terms of scientific objectivity we simply don't know what is happening at the microscopic and biochemical levels. These area will be explored during the 1987-89 AGDF studies. Finding the cause of the "laminitis like" condition will, undoubtedly, be very elusive and we can expect to do little more than scratch the surface. There are many variables suspected of being involved in the problem:- weaning protocol, acclimatization protocol, exercise, high energy ration, ration Ph, protein and fiber content of the ration. Nevertheless the 1987-89 AGDF studies should produce "general recommendations".

It should be realized that a similar "laminitis like" condition plagues dairy cows. The importance of this phenomenon has only been realized in the past five years. It should also be appreciated that studies in beef and dairy are extremely complementary in respect to this problem. In fact, if we had not received funding to support complementary research in dairy cattle, the beef work could not have progressed as far as it has. In the case of the dairy cow "stress" is a factor that is identifiable and more manipulable than it would be with beef cattle. In the future we shall be looking for practical ways of objectively evaluating stress in the animal and stressors in the environment.

Finally, we should not forget that some strange changes occur in the hooves of feedlot cattle. We do not plan to go into this particular phenomenon but it would seem quite likely that at some time in the future the results of our proposed studies will benefit the feedlot operator.

APPENDIX I

PREPARATION AND PHOTOGRAPHY OF CATTLE FOR COMPUTER ASSISTED MEASUREMENT RECORDING OF BODY DIMENSIONS

Objective

The objective is to produce a 35 mm transparency of an ox from which measurements of various structures can be made using a computer.

The accuracy of the photographic technique and identification of anatomical land marks is critical.

Photographic Instructions:

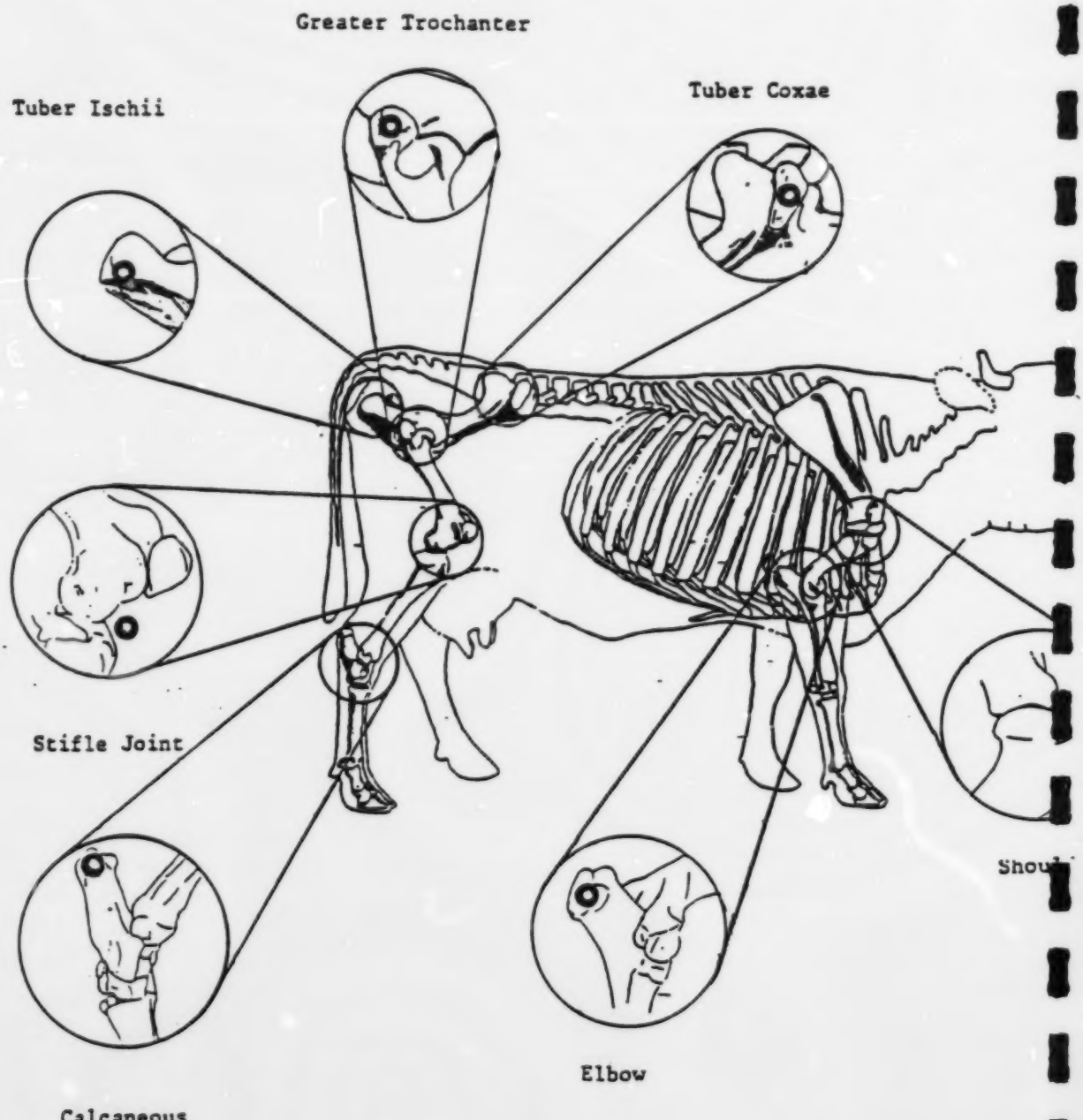
1. Use a 35 mm lens.
2. Elevate tripod to ensure that the center of the lens is half-way between the ground to the animal's mid-section.
3. Use the level on the tripod to ensure that the camera is leveled.
4. Place the camera approximately 3 meters from the animal.
5. Place the camera at a point approximately at the center of the animal's body. Ensure that the nose to camera distance is as nearly as possible equal to the tail to the camera distance.
6. Prepare a length of wood or similar material, exactly one meter in length and about 4 cm broad and 5 mm thick. Paint with green or black blackboard paint. When used, this measure is located over the midline of the animal. The identification of the animal must be inscribed on the measure together with the date.
7. Frame the animal as tightly as possible in the view finder of the camera.

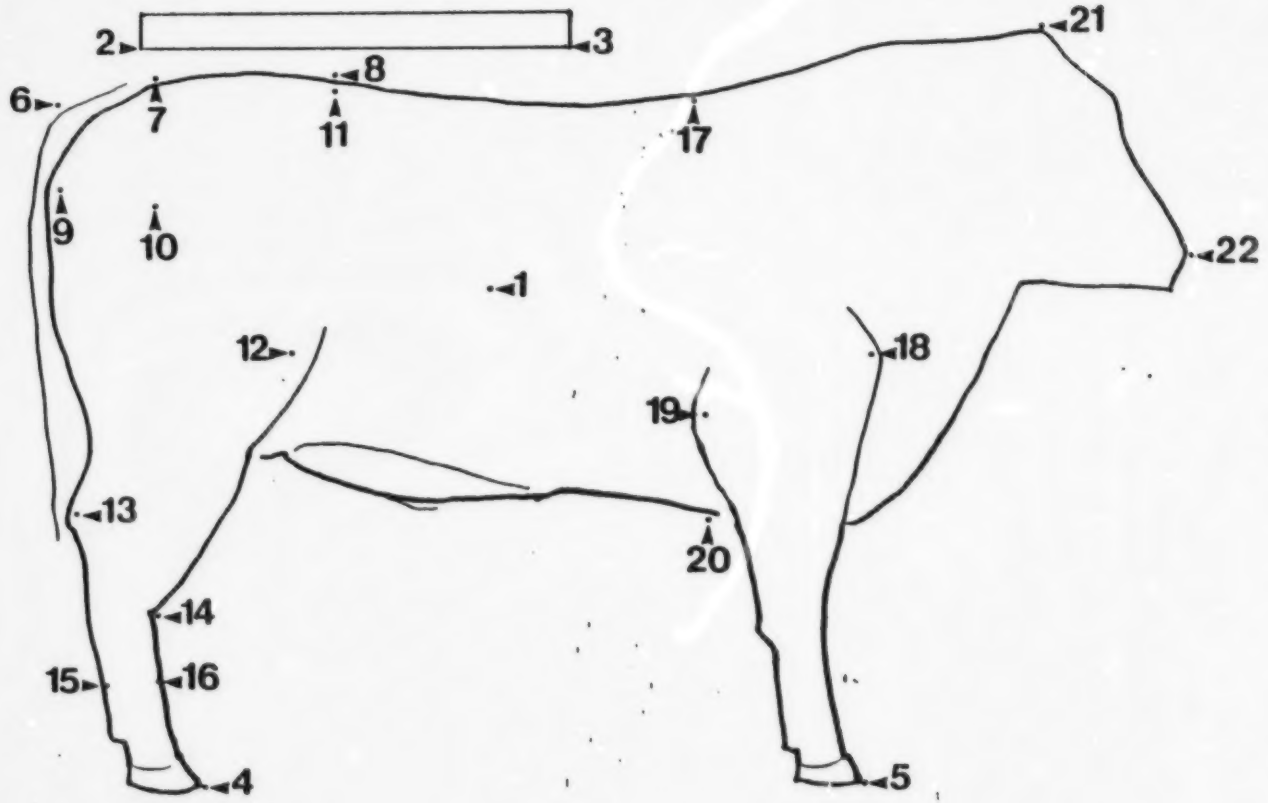
Anatomical Marking

Each point will be marked with yellow paint to touch a circle not more than 2 cm in diameter. Note that every yellow dot MUST be visible through the camera view finder.

1. Tuber Ischii (Pin Bone)
   This is the prominence located on each side of the tail. The inner edge is difficult to feel but the outer edge is easily felt. Make sure that you can clearly make out the outer edge and mark it.
2. Greater Trochanter (Thurl)
   Feel all around this structure which is not distinct because it is buried beneath muscle and fat. When you have a distinct uprising of general shape, mark the center of the prominence.
3. Tuber Coxae (Hip Bone)
   Again there are two edges, a top and the bottom edge. Place your middle finger on the top edge and the thumb on the lower edge and mark the center with your index finger. Place the paint at this point.
4. Stifle Joint (Beneath patella - Knee cap)
   Place the flat of the hand with fingers facing you between the belly and the stifle joint. Move your middle finger up and down the inside of the joint until you locate a depression between the bones. Then try to place your thumb around the flank and joint and place it at a point on the outside skin that corresponds to location of middle finger. Mark this point.

5. Calcaneus (Hock)
   The tip of the hock is more or less rounded. Imagine the round top as a segment of a circle and deposit your mark at the center.
6. Shoulder
   Find the most forward and distinctive point of the shoulder and mark.
7. Elbow
   Find the elbow and proceed as with the hock.

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PRESENTATIONS AND PUBLICATIONS

1. Greenough, P.R (1986) Data management - Bovine Lameness. Proceeding of Fourteenth World Congress on Diseases of Cattle. Dublin, Ireland

2. Greenough, P.R., Gacek, Z. (1986) A preliminary report on a laminitis like condition occurring in bulls under feeding trials, Proceedings of 5th International Symposium on disorders of the Ruminant Digit. Dublin, Ireland.

3. Greenough, P.R. (1987) A pilot study of subclinical laminitis in a dairy herd. Saskatchewan Dairy Producers Association Meeting, Regina.

4. Greenough, P.R (1987) Photographs, Computers and Conformation, Alberta Dairy Producers Association Meeting, Banff, Alberta.

5. Greenough, P.R. (1987) Fodder and Feet. Alberta Dairy Producers Meeting, Banff, Alberta.

6. Greenough, P.R. (1987) A method for measuring the conformation of cattle from a 35mm transparency with a digitizing pad and computer. Accepted for presentation at the XIII World Veterinary Congress, Montreal.

7. One report to the board of the Charolais Breeders Association and two reports to the Contributors Committee of the Saskatoon R.O.P. Station.

8. Demonstration of C.D.S at the Agriculture Canada Research Station in Lacombe. C.D.S. is to be tested a) to evaluate carcases and b) to relate the conformation of live animals to carcase quality.

9. C.D.S. Is being used by a PhD student in the Department of Poultry and Animal Science to measure increase in body height of groups of animals on different rations. C.D.S. was compared in 120 measurings against the use of a measuring stick. There was no statistical difference between the measurements obtained manually from those using C.D.S.

PERSONNEL INVOLVED IN THE PROJECT

Dr. Z. Gacek Veterinary Research Assistant 16months 70%

Mr. M. Ogunyele Technician 6 months 70%

Mr. P. Berg Computer programmer 6months 100%

Ms J. Kennedy Student Assistant 3 months 50%

TIMETABLE OF ACTIVITIES AND COLLABORATION WITH OTHER PROJECTS

September 1985

The work on the project started at this time despite the fact that no funding had been committed by the Horned Cattle Trust. Dr. D. Christensen funded salary for Dr. Z. Gacek ($3,740.00) and purchased the digitizer, camera, projector and various other items of equipment($6,639.65). These monies were derived from the ERDA Dairy Producers Grant Part II. The funding was provided on condition that as time permitted during 1986 certain studies would be carried out in Dairy Cattle. (Approximately $3,200.00 of salary was derived from a Saskatchewan Job Creation Program).

October/November 1985

Photographs were taken of 360 bulls in the R.O.P. station and black and white prints developed at University expense. (Approximately $400 U of S funding).

December 1985/January 1986

The parameters of conformation were measured manually from the photographs. The method proved so time consuming and unreliable that it was abandoned. These disappointing results led to discussions with Dr. of the college of dentistry who had developed a system by which a digitizer had been used to measure from an X-ray distances between anatomical points in preparation for orthodontic surgery. The computer programming for this system had been developed by Dr. Jim Kohler of Space and Atmospheric studies. Dr. Kohler agreed to help and loan us equipment on a trial basis. All of the black and white negatives were mounted as slides and projected on the digitizer. The system worked sufficiently well for us to decide to dedicate our efforts in developing this system. Dr. Kohler's digitizer had certain limitations but market research permitted us to acquire an instrument that was ideal for our purposes.

February 1986

All of the bulls were rephotographed this time using color color reversal fil. Trials on the best method for marking the anatomical points on the bulls had now been successfully completed, the desired measurements had been identified and the intial program for data storage had been developed.

March 1986

The final part of the R.O.P. test occurred on March 25th 1986. The evaluation for feet and leg soundness revealed that at least 25% of the bulls were showing clinical signs indistinguishable from laminitis or founder. This proved such a startling discovery that the observations were rechecked during a second special evaluation. Only one of the bulls,

meeting the R.O.P. criteria but failing on feet and legs was slaughtered therefore we were unable to confirm our findings post mortem.

April 1986

Of the 360 bulls on trial at the Saskatoon Station we were able to obtain both hind feet of sixty that had been slaughtered. These specimens were identified with the ear tag of the animal and frozen. Over the next months Dr. Gacek examined the hooves and developed a system for recording the lesions observed. All hooves showing lesions were photographed, the photographs were stored. It should also be noted that we examined 40 bulls on a feed trial supervised by Dr. H. Nicholson. The clinical and post mortem signs were comparable but not as severe in this group and no difference was observed between the group fed barley from those fed oats. At this time we ran short of materials and the livestock branch was able to keep us going with $800.00.

May 1986

Dr. Kohler identified a young man, Mr. Phil Berg, who had three years of experience in photography, a degree in mathematics and a degree in computer science. Phil would work full time until September and part time Until April on developing the digitization system. We were able to obtain an opportunities 86 student grant ($1,600) to defray a portion of the salary. A second student grant ($1,600) was obtained and a Veterinary Student, Frankie Kennedy, was employed. Frankie would assist with the digitization of the data from the photographs of the bulls and, throughout the summer, assist with the dairy project promised to Dr. Christensen.

At about this time we also examined the hooves of thirty steers and heifers that had originated from the Tremundy farm. The management in the feedlot had been comparable to that of the bulls but the lesions were almost absent. At a meeting with the faculty of the Dept. of Poultry and Animal Science it was concluded that the weaning protocol was a factor that should be considered when cattle are being evaluated. In the 1986/7 test all producers sending bulls to the station have been circularized and information has been received on weaning protocol and dam age at calving (potential milking qualities). This data will be considered when correlations are being generated.

June 1986

In collaboration with Mr. Rick Koller, Beef Cattle Feedlot specialist five feedlots were identified and the feet of ten animals were gathered from the slaughterhouse, examined and photographed. To this point we had not been able to define "normality" in the hoof quality of young beef cattle. The nutritional regimen of the five feedlots was significantly different and these differences were dramatically reflected in the quality of the hoofhorn.

July/August 1986

This was a period during which the digitization system was subjected to vigorous testing. Important flaws were discovered and corrected. Most of

the testing was carried out either on a skeleton or on dairy cows. The most important finding at this stage was that hoof conformation could not be determined from a photograph taken to measure body size. In such a photograph the image of the hoof was too small to provide accurate data. Following this finding a completely new separate digitization system was planned for development. New photographic equipment has been acquired and tested and appropriate photographs have been taken of the bulls in the 1986/7 test. The computer program will be developed for hoof conformation if fresh funding becomes available for the purpose.

September 1986

The dairy project continued during this period and it was at this time that we obtained a job creation progr-m grant ($5,233) and Mr. Michael Ogunyele started training as a technician for data collection and digitization. The evaluation of the hooves of cattle believed to have been foundered was concluded at this time. However, we were unable to make histopathological studies because at this time we do not have personnel with experience in this field who can be dedicated to such a study. Funding was also lacking to undertake assays of the mineral or protein content of the hoof horn. We also lack the equipment to evaluate horn hardness,. Therefore the study had to be limited to a gross study of the external surface of the hoof and of the macroscopic appearance of sections of the hoof. These observations provided no objective support for the theories that were developing but rather pointed the way for further work. We further believe that there may be a correlation between the findings of Dr. Larvald and his estimations of somatamedin but the final values of Somatamedin have only just become available.

October 1986

During this month the 1986/87 bulls entered the Saskatoon Station and questionnaires were issued to producers owning bulls at test in the station. A follow up was also conducted of the bulls passing through the spring 86 bull sales. Of the 63 responses (ouit of 106 bulls sold) only one animal had gone seriously lame from laminitis, two had proved infertile and two had unacceptably low libido which may or may not have been associated with sore feet. Conformation evaluation commenced at the end of the month and continued into November.

November 1986

The long process of digitization of the photographs of the hooves and the body commenced and was not finished until February 1988. In November we took a week to photograph the conformation of cattle at agribition. The reason for this diversion was to attempt breeder reaction to the concept of objective conformation evaluation. There was unanimous enthusiasm for the concept and significant condemnation of the standards set by the show ring judges. Show ring conformation seemed to be unrealistic and from a subjective evaluation it would appear that the conformation digitization system could prove an invaluable aid in establishing economically sound standards.

December 1986/January/February 1987

In addition to the tedious work of digitization a series of tests were undertaken during this period aimed at validating the accuracy of the conformation digitizing system. The results of these tests will be reported elsewhere.

March 1987

During the end of February and the first three days of March the bulls were all photographed and digitization cannot be completed because we will have no technical assistance from Mid-April onwards. On March 25th the bulls were examined for feet and leg soundness. This data has not been examined and the project has terminated.